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"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH

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LIFE OF SIR WILLIAM ROWAN HAMILTON

Life of Sir William Rowan Hamilton, Andrews Professor of Astronomy in the University of Dublin, and Royal Astronomer of Ireland; including Selections from his Poems, Correspondence, and Miscellaneous Writings. By Robert Perceval Graves, M.A., Sub-Dean of the Chapel Royal, Dublin. Vol. I. pp. 692. (Dublin University Press Series, 1882.)

WE are glad to welcome the appearance of the first volume of this work, which has long been eagerly watched for by those interested in the career of the wonderful genius whose life is here narrated. To many readers this volume will afford material for no little surprise. Sir William Rowan Hamilton is known to fame as a mathematician. He is known by his memoirs on systems of rays; by his discovery of the great dynamical generalisation which is implied in his theory of the characteristic function; by his exquisitely beautiful prediction of the phenomena of conical refraction; and above all by his theory of quaternions—an imposing mass of profound thought which must be ranked with the very greatest mathematical achievements of any age or nation. Yet here we have a very portly volume of almost seven hundred pages, of which only an extremely small fraction is devoted to Hamilton's mathematical work. The progress of his papers on rays is here and there referred to, and there is an interesting historical chapter on conical refraction, but we may turn in vain to the index for a reference to quaternions, and we have only noticed the word occurring once or twice in the entire volume. But the surprise will disappear when the reader begins to make acquaintance with the volume. He will then see that Hamilton's mathematical labours were only one of the forms in which his most extraordinary genius was manifested. He will see that the early years of Hamilton's life afforded such copious materials to a biographer that the present volume only extends to the time when Hamilton had attained the age of twenty-seven, and that the crowning achievement of quaternions by which

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Hamilton is best known was the fruit of his riper years, and belongs to his subsequent career.

At the Cambridge meeting of the British Association in 1833, Prof. Sedgwick spoke of Hamilton—then twenty-eight years old—as “a man who possessed within himself powers and talents perhaps never before combined within one philosophical character.” The volume before us bears testimony which would go a long way towards justifying this eulogium. We think that Sir W. Hamilton has been fortunate in having a biographer so careful in his facts and so skilful in the manipulation of his copious materials as Mr. Graves has proved himself to be. Hamilton had the habit of putting on record very minute circumstances. He preserved copies of a large proportion of the letters and notes written by him, whether important or not; he often recorded the hour at which they were despatched, and the person to whom they were intrusted for the post. The enormous mass thus accumulated during a long and very studious life were left at Hamilton's death in a state of utter confusion, and it has been the laborious duty of his biographer to extract from the mass those materials which were suitable for his purpose. The very extensive correspondence of Hamilton is also a source from which his biographer has obtained much aid. Of his own qualifications for the task the biographer thus modestly expresses himself in the preface:—

“The public has some right to inquire why one who has to confess himself to be no mathematician should have undertaken the present work. To such an inquiry I may reply as follows: that although unconnected with Sir W. R. Hamilton by any tie of kindred, I became his friend in the youth of both of us, and that our friendship continued unbroken till the day of his death; that when he was applied to by the Editor of the *Dublin University Magazine* in 1841 to name a friend who should be requested to supply to that magazine a biographical sketch for insertion in its portrait gallery of distinguished Irishmen, he did me the honour of designating me, and furnished me with the necessary facts; that he afterwards sought my consent to his nomination of me as his literary executor,—a nomination however which, he told me afterwards, he thought right to withhold when he found that the remainder of my life would probably be spent in England, and that I should therefore be unable to fulfil

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the duties of the trust without undue inconvenience. Lastly, that after his death I was asked by his sons to undertake the task, and was at the same time informed by several of the most influential of his friends that this selection met their approval, and that they were willing to trust to my judgment the correspondence over which they had control."

William Rowan Hamilton was born in Dominick Street, Dublin, on August 3-4, 1805. His father, Archibald Hamilton, was a solicitor. When the boy was little more than a year old, it would seem that he gave such indications of unusual talent that his parents decided to commit the education of the child to his uncle, the Rev. James Hamilton of Trim, a man of very remarkable talents, who, with his sister, Jane Sydney Hamilton, reared and educated the child. What that childhood was can be best described in the words of the biographer, who says, on pp. 46-47:—

"It will then be noted that, continuing a vigorous child in spirits and playfulness, he was at three years of age a superior reader of English and considerably advanced in arithmetic; at four a good geographer; at five able to read and translate Latin, Greek, and Hebrew, and loving to recite Dryden, Collins, Milton, and Homer; at eight he has added Italian and French, and gives vent to his feelings in extemporised Latin; and before he is ten he is a student of Arabic and Sanscrit. And all this knowledge seems to have been acquired not indeed without diligence, but with perfect ease, and applied, as occasion arose, with practical judgment and tact; and we catch sight of him when only nine swimming with his uncle in the waters of the Boyne. In this accomplishment he afterwards became a proficient."

Again, on p. 51 we have a description of a little manuscript book of 30 pages thus entitled "A Syriac Grammar. In Syriac Letters and Characters; Compiled from that of Buxtorf; Translated into the English Language and Syriac Characters by William Hamilton, Esq., of Dublin and Trim. Begun July 4th, 1817; Finished July 11th, 1817." The conclusion of the book is as follows:—"Thus have I gone through what is necessary to be known for reading and writing Syriac. . . . Soon may be expected an account of their irregular and indeclinable words, &c., with a syntax." The author of this production was still under twelve years old.

A couple of years later (November, 1819) we find Hamilton inditing a letter in Persian to the Persian ambassador, Mirza Abul Hassan Khan, then on a visit in Dublin. Hamilton has left a translation of this production, the following extract from which evinces the Oriental aroma which pervades the whole:—

"As the heart of the worshipper is turned towards the altar of his sacred vision, and as the sunflower to the rays of the sun, so to thy polished radiance turns expanding itself the yet unblossomed rosebud of my mind, desiring warmer climates whose fragrant and glorious splendour appear to warm and embalm the orbit about thee, the Star of the State, of brilliant lustre."

Hamilton's letter met with a very favourable reception; the secretary had observed no mistakes, and inquired whether he had not copied it from something, and the compliments bestowed on the author were all the more pointed, because "Captain Kian," who had also attempted to write a letter in Persian, was informed that his presence would be dispensed with, as *his* letter was totally unintelligible.

A large fraction of the present volume is filled with the poetical effusions, in which on all occasions Hamilton was prone to indulge. The first traces of these "showers of verse," as Wordsworth afterwards playfully called them, is found in Hamilton's letters to his sisters. The biographer has not, however, deemed it desirable to record any poetical effort prior to his sixteenth year, and the first piece we find is (p. 95) "To the Evening Star," of which the first stanza is—

"How fondly do I hail thee, Star of Eve,
In all thy beauty sinking to the west,
And as if loth our firmament to leave
Slow and majestic sinking to thy rest."

Hamilton lived and thought in an atmosphere of poetry; he wrote poems on all occasions and all sorts of subjects. It was perhaps not unnatural that as a disappointed lover he should bewail his sorrows in verse, that he should write birthday addresses to his sisters, and sonnets on the Beauty of the Dargle, but we also find him addressing an "Ode to the Moon under Total Eclipse," and to use his own words in writing to Wordsworth, "I have always aimed to infuse into my scientific progress something of the spirit of poetry, and felt that such infusion is essential to intellectual perfection." He has, however, indicated very clearly where his real ambition lay, for at the age of twenty, writing to his friend, Miss Lawrence, he says:—

"But while you concur with my own sober judgment in refusing to award me the crown of poetic power you would not I am sure desire to extinguish in me that love of 'sacred song' to which I can with truth lay claim. There is little danger of its ever usurping an undue influence over a mind that has once felt the fascination of science. The pleasure of intense thought is so great, the exercise of mind afforded by mathematical research so delightful, that having once fully known it, it is scarce possible ever to resign it. But it is the very passionateness of my love for science which makes me fear its unlimited indulgence. I would preserve some other taste, some rival principle; I would cherish the fondness for classical and for elegant literature which was early infused into me by the uncle to whom I owe my education, not in the vain hope of eminence, not in the idle affectation of universal genius, but to expand and liberalise my mind, to multiply and vary its resources, to guard not against the name but against the reality of being a mere mathematician."

A year later (1822) we find Hamilton entering upon the path of original mathematical discovery. The title of one of the first of these early papers is "Examples of an Osculating Circle determined without any Consideration repugnant to the utmost rigour of Analysis." With two others, one on "The Osculating Parabola to Curves of Double Curvature," and the other on "The Contacts between Algebraic Curves and Surfaces," Hamilton paid his first visit to Dr. Brinkley, then the Astronomer Royal of Ireland. Dr. Brinkley was impressed by their value and by the genius which at the age of seventeen had produced work of so much originality.

The first year of Hamilton's career in Trinity College, Dublin (1824), justified all the expectations entertained by his friends. In his Freshman year he distanced all his competitors alike in classics and in mathematics, while he was also awarded a Chancellor's prize for his poem on the subject of the Ionian Islands. In the same year we read that he commenced another friendship, which remained unbroken to the end of the long life of the brilliantly gifted Maria Edgeworth, and which brought to Hamilton

many of her delightful notes and letters, and in them cordial sympathy and wise counsel. Of Hamilton Maria Edgeworth writes: "Mr. Butler came with young Mr. Hamilton, an 'admirable Crichton' of eighteen, a real prodigy of talents, who, *Dr. Brinkley says, may be a second Newton.*"

At the age of twenty-one came the turning-point in Hamilton's career—his appointment to be Andrews Professor of Astronomy in the University of Dublin, and Royal Astronomer of Ireland. The vacancy arose from the promotion of Brinkley in 1826 to be the Bishop of Cloyne. The following incident of the occasion is given by his biographer:—

"Candidates for the post came over from England, among them Mr. Airy of Cambridge (already distinguished by his Senior Wranglership and by optical researches), and some who had already gained the rank of Fellow in Hamilton's own college were competitors. It appears that before the end of April he met Airy and other eminent men at the table of Dr. Lloyd, and we remember hearing that, in the scientific discussion to which the meeting gave occasion, he took his part with striking ability, modesty, and firmness, when it became necessary to defend some of his optical results against the objections of Mr. Airy."

Hamilton seems to have felt that it would be presumptuous for an inexperienced undergraduate to put himself forward as a candidate; he therefore retired to the country to carry on quietly his work for the classical medal. It was only a week before the appointment had to be made that he received at Trim, from his tutor, Mr. Boyton, an intimation that the Board were favourably disposed towards him, and urging him to come up at once to take the advice of his friends. That advice concurring with the strong opinion of his zealous friend and tutor, he was unanimously appointed on June 16, 1827.

A few months later Hamilton paid a visit to Keswick, and commenced his memorable friendship with Wordsworth. That the philosopher and the poet were mutually interested is manifest from Hamilton's account written in a letter to his sister Eliza:—

"He (Wordsworth) walked back with our party as far as their lodge, and then, on our bidding Mrs. Harrison good night, I offered to walk back with him while my party proceeded to the hotel. This offer he accepted, and our conversation had become so interesting that when we arrived at his home, a distance of about a mile, he proposed to walk back with me on my way to Ambleside, a proposal which you may be sure I did not reject, so far from it that when he came to turn once more towards his home I also turned once more along with him. It was very late when I reached the hotel after all this walking."

Hamilton quickly followed up his introduction to Wordsworth by sending him an original poem entitled "It haunts me yet." Wordsworth replies:—

"With a safe conscience I can assure you that in my judgment your verses are animated with the poetic spirit, as they are evidently the product of strong feeling. The sixth and seventh stanzas affected me much, even to the dimming of my eyes and faltering of my voice while I was reading them aloud. Having said this I have said enough. Now for the *per contra*. You will not, I am sure, be hurt when I tell you that the workmanship (what else could be expected from so young a writer?) is not what it ought to be. . . ."

"My household desire to be remembered to you in no formal way. Seldom have I parted—never, I was going

to say—with one whom after so short an acquaintance I lost sight of with more regret. I trust we shall meet again."

The biographer adds that Wordsworth has said in his hearing that Coleridge and Hamilton were the two most wonderful men, taking all their endowments together, that he had ever met.

At the commencement of his career at the Observatory Hamilton entered with diligence into the practical work of observing, but it would seem that the necessary exposure told injuriously on his health. It does not appear that he made any observations of importance. His tastes pointed strongly in the direction of mathematical research, and the development of his discoveries occupied more and more of his time, until at length, with the full consent of the authorities of the University, Hamilton practically relinquished all observatory work and gave his splendid mathematical genius full scope. Unquestionably this was the best course for the credit of Hamilton himself, best for the credit of his University, and best for the interests of science. Hamilton could never have made even a moderately successful practical astronomer. He tells Dr. Robinson that he disliked observing; he was essentially a man of speculation rather than of action. Like his friend De Morgan, Hamilton was not "a man of brass, a micrometer-monger, a telescope-twiddler, a star-stringer, a planet-poker, or a nebula-nabber"—he had none of the qualifications necessary for a routine of observatory work. His workshop was his study, where he sat immersed in what he calls his "mathematical trances" and elaborated his great discoveries.

The latter half of the volume describes his early life at the Observatory. He was fortunate in obtaining as a pupil Lord Adare, afterwards Earl of Dunraven, between whom and Hamilton a lifelong friendship of the tenderest character arose. Many other friendships are here copiously illustrated by the letters which have been preserved. The letters to and from Sir J. W. Herschel and Sir G. B. Airy relate chiefly to the discussion of Hamilton's labours on the systems of rays and other matters of purely scientific interest; but there are stores of other letters. The voluminous correspondence between Hamilton and Wordsworth will itself possess a wide interest even in circles where Hamilton's more serious labours are unknown. There are letters to and from Coleridge, as well as many others relating to purely literary matters. There is an extensive correspondence with Dr. Robinson, in which the Armagh astronomer gives kindly counsel to his younger brother at Dunsink. There is the correspondence with his friend, Aubrey de Vere. There are the numerous letters to his lady correspondents, to his sisters, to Maria Edgeworth, to Lady Dunraven, to Lady Campbell, and to Miss Lawrence. Then there is the visit of Hamilton to London, chiefly for the purpose of visiting S. T. Coleridge, to whom he had an introduction from Wordsworth; and there are interesting accounts of the visits of Wordsworth to the Observatory at Dunsink, where a shady walk in the garden still bears the poet's name.

A chapter towards the close (p. 623) gives a sketch of the discovery of conical refraction made in the year 1832, while the author was still only twenty-seven. The importance of this discovery was speedily recognised, and the biographer writes: "At the Cambridge meeting of the

British Association, 1833, the attention of the mathematical and physical section was largely given to the subject, and Herschel, Airy, and others spoke warmly in praise of the discovery. In the introductory discourse with which the proceedings of that meeting was opened, Prof. Whewell made it a topic, and expressed himself in the following words: 'In the way of such prophecies few things have been more remarkable than the prediction that under particular circumstances a ray of light must be refracted into a conical pencil, deduced from the theory by Prof. Hamilton and afterwards verified experimentally by Prof. Lloyd.' Previously, in the same year, Prof. Airy had publicly recorded his impression upon the subject as follows: 'Perhaps the most remarkable prediction that has ever been made is that lately made by Prof. Hamilton.'

The view Hamilton himself took of the discovery of conical refraction was characteristic. "It was," he writes to Coleridge on February 3, 1833, "a subordinate and secondary result when compared with the object I had in view to introduce harmony and unity into the contemplations and reasonings of optics regarded as a branch of pure science."

At the close of this volume we still leave Hamilton quite a young man. The great labour of his life has not yet commenced; its nature has not indeed even dawned upon him. We shall therefore look forward with pleasure to the continuation of the present most interesting work. The development of Hamilton's more mature genius, his correspondence with De Morgan, in itself no inconsiderable mass, and above all the gradual evolution of quaternions, will form most attractive materials for his biographer.

It is by the liberality of the Board of Trinity College, Dublin, that the present instalment of the work has been brought out, and we sincerely trust that the same liberality will be extended to enable the biographer to continue to do real justice to his subject. But besides the present work another debt is due to his memory. Hamilton's earlier papers are very inaccessible: many of them are scattered about in various periodicals, and his two noble treatises on quaternions are out of print. A complete edition of Hamilton's works would be an appropriate sequel to this biography, and they would be not unfitting companions for the works of Lagrange and of Gauss. It is not often that a University has so gifted a son as Hamilton. Let us hope that the University which is proud to claim him will see fit to raise this further monument to his genius.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.]

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.]

Sheet-Lightning

IN NATURE, vol. xxvii. p. 576, a statement is made that the "opinion so long and generally entertained" that "sheet-lightning and the so-called summer or heat-lightning are nothing else than

the reflection of, or the illumination produced by distant electrical discharges, is not supported by observation." This statement surprises me, for I should have said that the opinion once commonly entertained that sheet-lightning is a distinct form of lightning unaccompanied by sound, is now for the most part rejected, the results of observation being distinctly against it. The question is an old one; but as the writer of the above statement only refers to the observations made at Oxford during the twenty-four years ending 1876, I will confine myself in the main to an examination of these. I must premise that I do not assert that lightning never occurs at such an altitude that the thunder accompanying it is not audible. In rare instances in Europe lightning is observed in the zenith, followed after an interval of twenty seconds or more by faint rolling thunder immediately overhead. It is therefore antecedently probable that lightning may occur at too great an elevation for the thunder to be heard at the earth's surface at all; and this is especially likely to happen in some of those thunderstorms within the tropics, the altitude of which is extremely great.

The distance at which the illumination produced by lightning in a dark night can be observed depends upon the altitude and the intensity of the discharge, and further upon the altitude, character, and amount of the clouds. It is possible that the diffused particles of ice (at a much greater altitude than the cirri), which produce the phenomenon called "rayons du crépuscule," are capable in some cases of reflecting the illumination. However this may be, it is certain that the illuminations of an ordinary thunderstorm at midnight, when there is no moonlight, have an average radius of more than forty miles. The distance at which thunder is heard depends on a variety of conditions; but we may safely state that in the open country in calm weather at midnight the sound is rarely heard at a greater radius than fifteen miles. At the Radcliffe Observatory, which is scarcely out of the reach of rumbling sounds produced by the traffic of a town, the average distance at which thunder is distinguished may probably be safely reduced to seven miles. Assuming then that at Oxford the area of illumination has a radius of forty-two miles, and that of thunder one of seven miles (and in this assumption we are probably not very far from the truth), we conclude that in the darkest hours "lightning without thunder" should occur at Oxford with a frequency which is expressed by the figures 35:1 as compared with "thunder with or without lightning." A deduction ought, of course, to be made for the effects of moonlight. But when this has been made, the figures quoted by your reviewer are not only satisfied by the hypothesis for the refutation of which he employs them, but further, if his mode of reasoning were legitimate, they would lead us to the conclusion that in nearly seven cases out of eight the thunder heard at Oxford is not the result of electrical discharge at all! Such thunder does not occur elsewhere, and was not in vogue at Oxford "in my time."

Practically, however, two considerations must not be omitted: (1) some localities enjoy a special immunity from thunderstorms, while others are responsible for the production of an exceptionally large number; in the former the frequency of illumination will be greater in comparison with the frequency of thunder, in the latter it will be less: (2) and this is a consideration of much more importance, though frequently neglected when a conclusion is deduced from records of phenomena) the relative frequency of two sets of occurrences often differs widely from the relative frequency of the records of the occurrences. The relative frequency of records of thunder and of lightning is to a large extent dependent on the position of the observer's residence, his habits, the keenness of his eyes and ears respectively, and his attentiveness to the impressions which those organs respectively experience.

No one who has on a summer night carefully watched the gradual approach of a great thunderstorm, counting the flashes, and registering the time-interval and number of claps from the minute when the first flickers begin above the southern horizon to that at which the storm is in its full roar and rattle overhead; no one who in a long night journey by train has run into a thunderstorm whose distant coruscations he has noticed two or three hours beforehand; no one, at least, who after watching sheet-lightning in one particular direction has made careful inquiries as to the occurrence or otherwise of thunder over the district from which the light proceeded, will hesitate in pronouncing the verdict that ordinary sheet or summer lightning is simply the illumination produced by a distant thunderstorm.

W. CLEMENT LEY